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IS : 1448 [P : 9] - 1960
Adopted : 8 *September* 1960
(Reaffirmed 2002)

Indian Standard

METHODS OF TEST FOR PETROLEUM AND ITS PRODUCTS

[P : 9]

CETANE NUMBER

(Fourth Reprint NOVEMBER 1991)

UDC 665·5 : 621·43·019·265

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 2

March 1962

CETANE NUMBER

(P : 9)

Adapted from ASTM Designation : *D* 613-58 *T*

1. SCOPE

1.1 This method describes the test for determining the ignition quality of diesel fuels in terms of cetane number.

2. TERMINOLOGY

2.0 For the purpose of this method, the following definition shall apply.

2.1 Cetane Number — The whole number nearest the percentage by volume of normal cetane in a blend with α-methyl naphthalene that matches the ignition quality of the fuel when compared by this method.

3. OUTLINE OF THE METHOD

3.1 The cetane number of a diesel fuel is determined by comparing its ignition quality with those for blends of reference fuels of known cetane numbers under standard operating conditions. This is done by varying the compression ratio for the sample and each reference fuel to obtain a fixed 'delay period', that is, the time interval between injection and ignition. When the compression ratio for sample is bracketed between those for two reference fuel blends differing by not more than five cetane numbers, the rating of the sample is calculated by interpolation.

4. APPARATUS

4.1 The apparatus* consists of a single cylinder engine of continuously variable compression ratio, with suitable loading and accessory equipment and instruments on a stationary base.

5. REFERENCE FUELS

5.1 Primary Reference Fuels

a) †*n-Cetane* — conforming to the following requirements. This fuel in its pure state has, by definition, a cetane number of 100.

Freezing point	not lower than 16·2°C
Hydroxyl number	nil

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* For further details, refer to ASTM Manual of Engine Test Methods for Rating Fuels, 1952, and the 1953 and 1957 Supplements.

† *n*-Cetane is available from E.I. Du Pont de Nemours & Co. Inc., Petroleum Chemicals Division, Wilmington 98, Delaware, USA.

Iodine number	nil
Colour	water-white
Sediment	none
Distillation :	
a) 5 percent by volume point	286·6 ±1·0°C
b) Range	within 6°C

b) *a-Methyl naphthalene*[*] — conforming to the following requirements. This fuel in its pure state has, by definition, a cetane number of 0.

Freezing point	below −20°C
Distillation :	
a) 5 percent by volume point	242·0°C
b) 95 percent by volume point	244·5°C

5.2 Secondary Reference Fuels — Certified secondary reference fuels are normally used in actual testing by the cetane method. Batches of such secondary reference fuels *T* and *U*[†], are calibrated as required against *n*-cetane and α-methyl naphthalene.

6. OPERATING CONDITIONS

6.1 The following operating conditions are mandatory.

6.1.1 *Engine Speed* — 900±9 rpm constant within 9 rpm during a test.

6.1.2 *Injection Advance* — 13·0 degrees before top dead centre.

6.1.3 *Injector Opening Pressure* — 105·5±3·5 kg per sq cm (or 1 500±50 lb/in^2).

6.1.4 *Injection Quantity* — 13·0±0·2 ml/min (that is, 13·0 ml in 60±1 second). Make this adjustment for each sample.

6.1.5 *Injection Pump Setting* — The inlet port in the barrel of the injection pump closes when the plunger has moved 2·11±0·18 mm (or 0·083±0·007 in) from the base circle of the cam[‡].

6.1.6 *Injector Pintle Valve Lift* — 0·13±0·03 mm (or 0·005±0·001 in).

6.1.7 *Injector Water Jacket Temperature* — 38 ±3°C (or 100 ±5°F).

6.1.8 *Valve Clearances* — 0·20±0·02 mm (or 0·008±0·001 in) measured with the engine hot and running under standard operating conditions on a reference fuel of 50 cetane number.

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[*] α-Methyl naphthalene is available from the Reilly Tar and Chemical Co. Indianapolis, Indiana, USA.

[†] Secondary Reference Fuels T & U and Calibration Tables are available form Shell Oil Co. Inc., Wood River, Illinois, USA.

[‡] For further details refer to Supplement IV of 1952 ASTM Manual of Engine Test Method for Rating Fuels and the 1953 and 1957 Supplements.

6.1.9 *Crankcase Lubricating Oil* — SAE 30, having a kinematic viscosity range of 9·62 to 12·94 cS at 99°C (or 210°F).

6.1.10 *Oil Pressure* — 1·8 to 2·1 kg/cm^2 (or 25 to 30 lb/in^2).

6.1.11 *Oil Temperature* — 57 ±8°C (or 135 ±15°F) with the temperature sensitive element completely immersed in the crankcase oil.

6.1.12 *Coolant Temperature* — 100 ±2°C (or 212 ±3°F) constant within 0·5°C (or 1°F) during a test.

6.1.13 *Intake Air Temperature* — 66 ±1°C (or 150 ±1°F).

6.1.14 *Compression Ratio Adjustment* — Set the micrometer on cylinders of standard bore to read 50·80 mm (or 2·00 in) (10 to 1 compression ratio) when the clearance volume is 72 ml to the top face of the combustion pick-up hole. Volumetric measurements shall be made with the piston at top dead centre and with the piston overtravel set at 0·38±0·03 mm (or 0·015±0·001 in) by using shims between the crankcase and cylinder.

7. STARTING AND STOPPING ENGINE

7.1 Starting the Engine — While the engine is being motored, open the by-pass and pump-drain valves of the fuel bowls in use, long enough to purge the fuel system of entrapped air; then close the valves and increase the compression ratio until the engine fires.

7.2 Stopping the Engine — Open the fuel by-pass valve, turn off the power switch on the ECS-1 meter, and then stop the synchronous motor. To avoid possible corrosion and warping of the intake and exhaust valves and seats between operating periods, close both valves by turning the flywheel to top dead centre on the compression stroke.

8. IGNITION DELAY METER, MODEL ECS–1[*]

8.1 The ignition delay meter, model ECS-1, has a three position selector switch marked CALIBRATE, INJECTION ADVANCE, and IGNITION DELAY. A control is also provided for making the basic calibration setting.

8.1.1 *Calibration*[†] — After the engine is started, rotate the selector switch to the CALIBRATE position and turn on the power switch for the ECS-1 meter. After a brief warm-up period, adjust the calibration control for a meter deflection of exactly 25 degrees. Following this adjustment, leave the selector switch on the CALIBRATE position for at least 10 minutes. At the end of this time, check the meter deflection and, if necessary, readjust to exactly 25 degrees. This completes the adjustment for calibration. However, as changes in temperature or supply voltage will change the meter deflection, it is advisable to return to the CALIBRATE position at periodic intervals during testing to check the calibration. If these checks show that the meter deflection is not at the calibration point, readjust the control for a deflection of exactly 25 degrees. Now check the meter for zero by rotating the selector switch to the INJECTION ADVANCE position and opening the fuel by-pass valve at the injector to stop firing of the engine.

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[*] Manufactured by The Solartron Electronic Group Ltd.; and available from the Waukesha Motor Co., Fuel Research Division, Waukesha, Wisconsin, USA.

[†] Detailed instructions for calibration and use of the instrument are given in the 1957 Supplement to ASTM Manual of Engine Test Method for Rating Fuels.

8.1.2 *Injection Quantity* — With the engine operating on the test fuel, adjust the fuel micrometer at the fuel pump to inject 13·0±0·2 ml of fuel per minute. Record the micrometer setting required for the correct injection rate.

8.1.3 *Injection Timing* — While still operating on the test fuel, rotate the selector switch to INJECTION ADVANCE. Adjust the injection timing micrometer at the fuel pump to give a deflection of 13 degrees on the meter. With this reading, fuel injection begins at 13 degrees before top dead centre.

8.1.4 *Ignition Delay* — Rotate the selector switch to IGNITION DELAY. Then adjust the cylinder length with the handwheel for a meter reading of 13 degrees. Make the final adjustment of cylinder length by turning the handwheel in a clockwise direction to eliminate a false reading because of backlash in the handwheel mechanism. Record the combustion-chamber length (handwheel setting) giving a meter deflection of 13 degrees. With this meter reading, ignition is occurring at top dead centre which is 13 degrees after the time of fuel injection.

8.1.5 From the handwheel setting required for a meter reading of 13 degrees the approximate cetane number of the test fuel may be estimated from previous information on the same engine.

9. BRACKETING THE TEST FUEL

9.1 Operate the engine on a trial blend of reference fuels, based on the estimated cetane number of the sample. Check and, if necessary, adjust the injection rate to 13·0±0·2 ml of fuel per minute. Record the micrometer setting giving the correct injection rate. Adjust the injection timing in accordance with **8.1.3** to 13 degrees before top dead centre. Then adjust the handwheel as described in **8.1.4** to give an ignition delay of 13 degrees and record the handwheel reading.

9.2 Operate the engine on a second trial blend of the reference fuels, differing from the first by not more than five cetane numbers, and repeat the procedure described in **9.1**.

9.3 If the handwheel setting for the sample is bracketed by those for the reference fuels, continue the test; otherwise try additional blends until this requirement is satisfied. Repeat the operation on both the sample and each of the final reference blends at least twice, adjusting the injection rate and timing as necessary to maintain standard conditions. In changing fuels, always allow at least 5 minutes before taking readings, to insure thorough flushing of the injection system and to let the engine reach equilibrium.

10. REPORTING OF RESULT

10.1 Average the handwheel readings on the sample and bracketing reference fuels obtained in accordance with **9** for the sample and each of the final reference fuels. Determine the cetane number by interpolation from these average readings.

10.2 Report the cetane number to the nearest integer. When the interpolated figure ends with 0·50, round off to the nearest even whole number; for example, report 50·50 as 50 and not 51; but 51·50 as 52 and not 51.

11. PRECISION

11.1 Extensive data from independent laboratories over a number of years for many samples of conventional diesel fuels have shown a standard deviation of 1·4 cetane numbers (average deviation of about 1·0 cetane number). Based on this standard deviation, the number of tests required to yield a rating of desired accuracy is given below:

Accuracy desired, Cetane Number, Plus or Minus	Number of Test Required to Obtain the Desired Accuracy		
	9 times out of 10	19 times out of 20	99 times out of 100
2	1	2	3
1	5	8	13

11.2 The tabulation in **11.1** shows that a single rating can normally be expected to be within ±2 cetane numbers of the true value in about 9 cases out of 10. On the other hand, if any accuracy of ±1 cetane number is desired with a certainty of 90 percent (9 times out of 10), it is necessary to obtain an average of five ratings in five different engines (preferably in five independent laboratories).

11.3 Although the precision specified applies to conventional diesel fuels when careful attention is given to the details of test procedure and engine condition, it does not necessarily apply to fuels which differ materially from finished diesel fuels. In such cases, the reproducibility is likely to be poorer and result in higher standard deviations.

AMENDMENT NO. 1 JANUARY 1986

TO

IS:1448[P:9]-1960 METHODS OF TEST FOR PETROLEUM AND ITS PRODUCTS

[P:9]

CETANE NUMBER

(*Page 4, clause 6.1.14*) - Add the following new clause after 6.1.14:

'6.1.15 *Test Fuel* - All fuel samples should be heated to +5°C above cloud point before analysis of cetane number.'

(PCDC 1)

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